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A Structural and Paleomagnetic Analysis of the Basalts of Summit Creek

Anne Fetrow
afetrow@pugetsound.edu

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Anne Fetrow* and Professor Mike Valentine
University of Puget Sound
Tacoma, WA
afetrow@pugetsound.edu

Abstract

This study is a detailed analysis of the structural geology and paleomagnetism of the Basalts of Summit Creek. Located southeast of Mount Rainier, this section of layered basaltic flows formed during the Eocene Epoch (55 to 45 Ma). The exact origin of the Basalts of Summit Creek is unknown, but there appears to be a growing connection between the Basalts of Summit Creek and the Crescent Basalts, which are Eocene flood basalts located on the Olympic Peninsula (Clark, 1989). This study attempts to provide a greater understanding of the emplacement and deformation of the Basalts of Summit Creek and any possible relationship with the Crescent Basalts. Once paleomagnetic directions were corrected for core orientation and bedding tilt, none of the flows yielded orientations consistent enough to provide reliable magnetic directions for the section. The scattered magnetic orientations are quite similar to those observed in the Crescent Basalts. This is does not demonstrate a definite connection between the two chemically similar Eocene volcanic sequences, but it does provide another similarity on the growing list. These two sections require further study to obtain the information needed to show a conclusive relationship beyond just their likeness in age, chemical and degree of alteration.

Research Questions

The purpose of this study was to examine the Basalts of Summit Creek with the goal of better understanding the paleomagnetic directions recorded in these basalts and identify any structures. The following were the key research questions:

- What paleomagnetic directions, if any, are present in the Basalts of Summit Creek?
- What internal structures are present?
- How does the paleomagnetic data collected from the Basalts of Summit Creek compare to that from the Crescent Basalts?

Methods

Several field excursions were taken to the section to collect structural and mapping data and paleomagnetic drill cores. Work was conducted along Hwy 12 and farther north in Gifford National Forest.
The following sites were determined by exposure quality and accessibility.

- 25 mapping sites
- 10 drill sites

All but twelve cores were demagnetized using alternating field demagnetization and the remainder was demagnetized using thermal demagnetization. Magnetic directions were determined using a Molspin Minispin spinner magnetometer. Structural data were plotted on stereonets and Google Earth maps.

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Figure 1. A. Cut and cleaned rock cores, ready for demagnetization. B. Orientation of core with sun and magnetic compass. C. Anne Fetrow drilling a rock core along Hwy 12.

References

Clark, Kenneth P. "The Stratigraphy and Geochemistry of the Crescent Formation basalts and the bedrock of geology of associated igneous rocks near Bremerton, Washington." Master's dissertation: Western Washington University. 1989.
Orr, Elizabeth L. and William N., University of Oregan. "Geology of the Pacific Northwest". The McGraw-Hill Companies, Inc. 1996. Print.
Valentine, M.J., Field, S., Lowther, J.S., Nyberg, E., and Normand, A., "Altered magnetic minealogy of Crescent Formation basalt flows (abs): Cordilleran Section", Geological Society of America, Abstracts with Programs, v. 33, p. A-45. 2001

Geologic Setting

The Basalt of Summit Creek are located southeast of Mt. Rainier in the Cascade Range of Washington, near to the intersection of Hwy 123 and Hwy 12. They erupted as flood basalts during the Eocene and have since been severely altered, faulted and deformed into their present day position (Orr et al., 1996). The Basalts of Summit Creek consists of subaerial basalt flows interbedded with volcanic tuffs and shales. There is approximately 2,000 m of exposed section that dips steeply to the west. The Basalts of Summit Creek erupted during a time of unique volcanism in the Pacific Northwest. While compressional forces were creating the Cascade Range, there is also evidence of extensional forces, i.e. flood basalts and normal faulting (Orr et al., 1996).

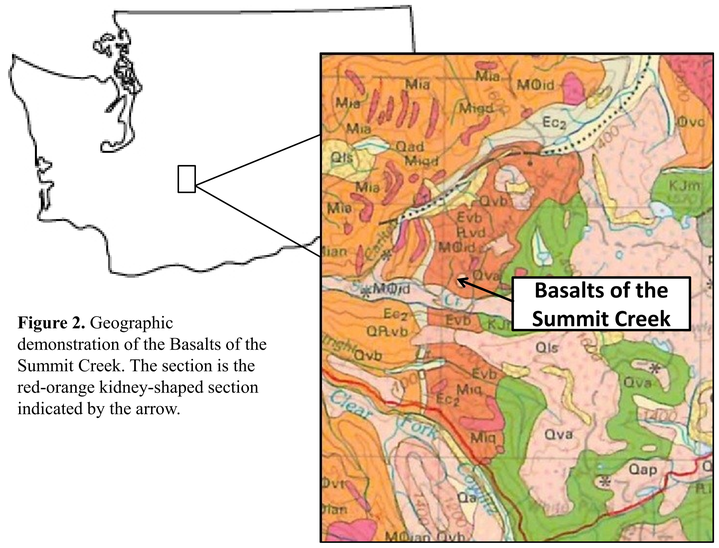

Figure 2. Geographic demonstration of the Basalts of the Summit Creek. The section is the red-orange kidney-shaped section indicated by the arrow.

Paleomagnetic Results

The magnetic directions obtained from the cores exhibit a great deal of scatter. As a result, none of the sampled flows produced a consistent magnetic direction. See the table below for determined flow directions. This scatter is believed to be due, in part; to hydrothermal alteration that has subsequently affected the Basalts of Summit Creek. This inconsistency in direction strongly resembles the scatter in paleomagnetic directions shown by work done on the Crescent Basalts (Valentine et al.,2001).

							VGP	
Sample Site	Declination	Inclination	N	R	alpha95	k	Lat.	Long
ASC03	62.98	10.89	6	3.72	60.28	2.19	N46 39.229	W121 28.278
ASC05	240.38	-15.71	3	2.92	24.77	25.83	N46 39.918	W121 28.989
ASC06	71.28	11.74	6	4.82	36.94	4.24	N46 39.570	W121 28.613
ASC08	61.77	19.77	8	3.69	67.89	1.63	N46 39.312	W121 28.299
ASC70	316.22	-82.67	6	2.56	95.74	1.46	N46 43.029	W121 27.955
ASC71	86.46	-4.03	3	1.81	179.98	1.69	N46 43.049	W121 27.965
ASC72	598.56	42.92	2	1.72	179.99	3.6	N46 43.071	W121 28.049

Table 1. Paleomagnetic data determined from sampled flows.

Acknowledgements

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Structural Mapping Results

Mapping of the section shows a great deal of variance in the strikes and dips. The lava flows throughout the area, with a many exceptions, have a northeast strike and a northwest dip. Along the middle transect of the section, nearest to Pony Creek and Carleton Ridge, bedding orientation has greater variability suggesting that there may still be unidentified structures that are influencing the area. Inability to identify more concrete structures was due to poor exposure and accessibility. The stereonet below shows flow orientations.

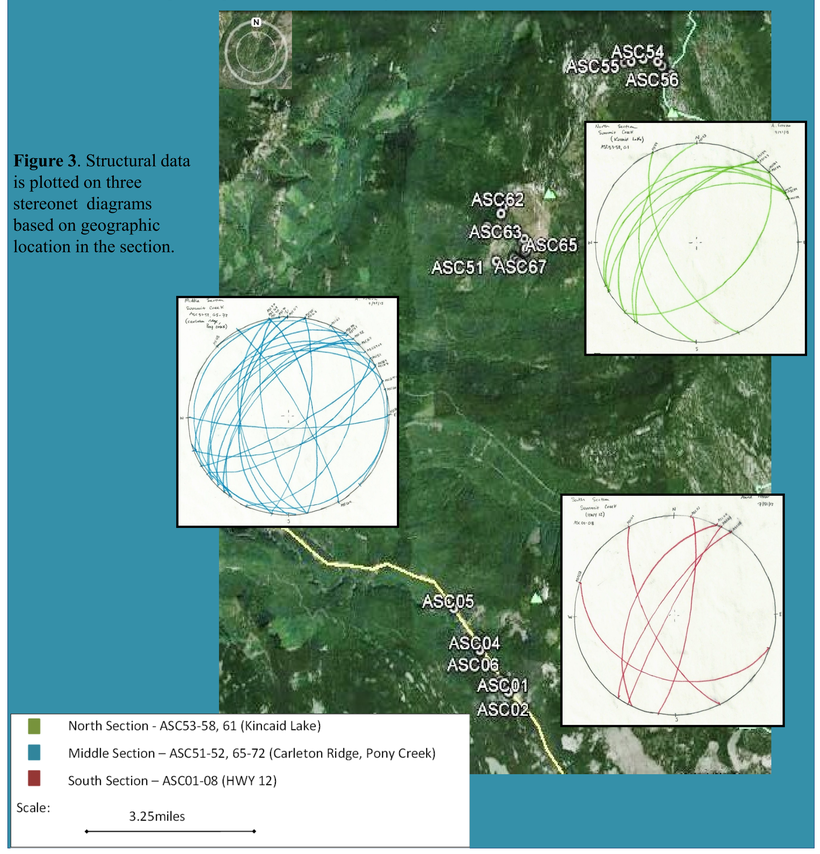

Figure 3. Structural data is plotted on three stereonet diagrams based on geographic location in the section.

Conclusions

The Basalts of Summit Creek remain difficult to tease meaningful conclusions from because of the high levels of alteration that these rocks have undergone post eruption. The inconclusive directions produced from both the Basalts of Summit Creek and the Crescent Basalts demonstrate yet another similarity between the two. This could mean that both sections have a comparable and perhaps related origin and alteration history. Structurally, the Basalts of the Summit Creek appear to have undergone significant folding and faulting. The vegetation and resulting poor exposure made determining the location of these presumed faults unrealistic for this study.

Future Work

As discussed in the results, the paleomagnetic potential for this section is dwindling. However, there are other key steps that should follow this project. With the investigation of the following, a more complete picture of the Basalts of Summit Creek and their connection with the Crescent Basalts can be drawn.
Further field reconnaissance
2. Reflected light microscopy
   used to identify the magnetic minerals present and determine the degree of alteration
3. K/Ar Dating
   used to obtain tighter age constraints for the section